Community Conservation Assessment for Rich Woods Community

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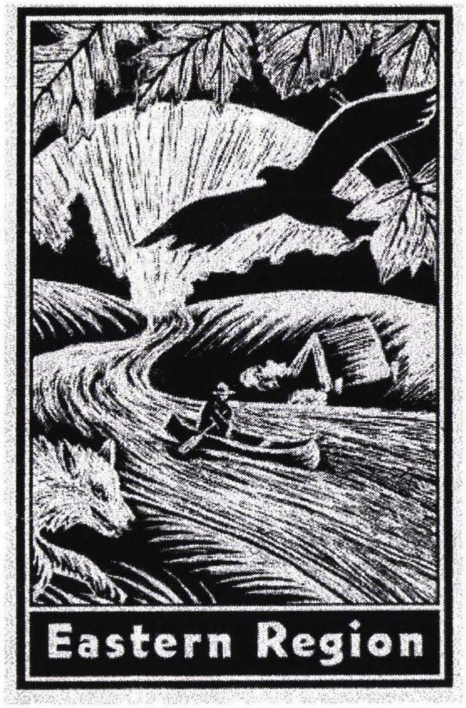

USDA Forest Service, Eastern Region

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WHITE MOUNTAIN NATIONAL FOREST

This Conservation Assessment/Approach was prepared to compile the published and unpublished information on the subject taxon or community; or this document was prepared by another organization and provided information to serve as a Conservation Assessment for the Eastern Region of the Forest Service. It does not represent a management decision by the U.S. Forest Service. Though the best scientific information available was used and subject experts were consulted in preparation of this document, it is expected that new information will arise. In the spirit of continuous learning and adaptive management, if you have information that will assist in conserving the subject taxon, please contact the Eastern Region of the Forest Service Threatened and Endangered Species Program at 310 Wisconsin Avenue, Suite 580 Milwaukee. Wisconsin 53203.

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EXECUTIVE SUMMARY

The purpose of this document is to provide background information necessary to prepare a Conservation Strategy, including management actions to conserve species discussed in this assessment. It is based on information presented in individual species Conservation Assessments, community occurrence data obtained from State Natural Heritage Programs, and information available in the literature.

The Rich Woods Community of the White Mountains National Forest is typically found in small pockets within a greater matrix of northern hardwood forest. It is limited in extent and distribution by availability of suitable habitat and by land use history. Rich Woods are distinguished by the nutrient availability of their soils and the landscape position occupied by these communities is often the most important factor in their existence. In New Hampshire, Rich Woods are mainly found in colluvial situations where downslope movement of organic and fine mineral material collects such as concave hillsides, bases of ledges or slopes, talus slopes, ravines or drainages. Rich Woods can also be found where calcium rich or circumneutral bedrock is near the surface or on calcareous or circumneutral till, more common in Vermont.

The overstory is typically mature, uneven aged sugar maple with basswood, ash and beech as common associates. The dense shade cast by this canopy encourages the development of ephemeral and aestival herbs adapted to low light conditions. The lush growth of herbs distinguished this community from the typical northern hardwood community commonly associated with the northeast.

Nine White Mountains National Forest Regional Forester Sensitive Species occur within this community as well as 12 Green Mountains National Forest Sensitive Species. A number of the species can be found in habitats other than the Rich Woods, but many are Rich Woods obligates.

The primary threat to this community is loss of appropriate habitat to development or logging. Once the canopy is destroyed, it can take 300 to 400 years for this community to recover.

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COMMUNITY CLASSIFICATION SYSTEM AND SYNONYMS

Because any community classification system is an attempt to categorize the infinite complexities of the natural world, community classification systems over a wide geographic range will inherently differ from one another based on geographic, geologic and climatic differences. In addition, classification systems differ in their purpose and thus produce different decisions in whether community types will be lumped or split. While splitting results in finer detail, it also reduces the applicability of community type to a more local geographic region.

The following information from Association for Biodiversity Information (ABI) database (www.natureserve.org) provides the closest match to the rich woods as defined by the Regional Forester Sensitive Species

Scientific name	*Acer saccharum-Fraxinus americana-Tilia americana/Acer spicatum/Allium tricoccum-Caulophyllum thalictroides* Forest
Translated scientific name	Sugar maple-Ash-Basswood/Mountain Maple/Ramps-Blue Cohosh Forest
Common name	Sugar Maple-Ash-Basswood Northern Appalachian Rich Mesic Forest
Unique Identifier	CEGL005008
Classification Code	I.B.2.N.a.5

Ecological System	Terrestrial
Formation Class	I – Forest
Formation Subclass	I.B – Deciduous forest
Formation Group	I.B.2. Cold-deciduous forest
Formation Subgroup	I.B.2.N.a – Lowland or submontane cold-deciduous forest

Table 1 lists the community classification systems in Region 9 that best describe community types that contain some or all of the species of interest in this assessment.

Table 1. Classification system approximate synonymy.

Classification System	Community Name	Rank	Citation
Association for Biodiversity Information	*Acer saccharum – Fraxinus americana – Tilia americana / Acer spicatum / Allium tricoccum / Caulophyllum thalictroides forest*	G4	NatureServe 2002
NH Natural Heritage Inventory	Rich Mesic Forest	S3	Natural Communities of New Hampshire: A Guide and Classification (Sperduto 11/2000 *draft*).
Vermont Nongame and Natural Heritage Program	Rich Northern Hardwood Forest	S4	Wetland, Woodland, Wildland (Thompson and Sorenson 2000)
Maine Natural Areas Program	Maple-Basswood-Ash Forest	S3	Natural Landscapes of Maine: A Classification of Vegetated natural Communities and Ecosystems. (Gawler 2001 *draft*).
Massachusetts Natural Heritage and Endangered Species Program	Rich Mesic Forest	S3	Classification of the Natural Communities of Massachusetts (Swain and Kearsley 7/2000 *draft*).
Connecticut	*Acer saccharum - Fraxinus americana / Asarum canadensis* community	S2?	Vegetation Classification for Connecticut (K.J. Metzler & J.P. Barrett 9/06/2002 *draft*)
Michigan Natural Features Inventory	Mesic Northern Forest (Northern Hardwood Forest; Hemlock-Hardwood Forest)	S4	Michigan Natural Community Types Michigan Community Ranks List, Michigan Natural Features
New Jersey	Dry-Mesic Calcareous Forest		
New York Natural Heritage Program	Maple-Basswood Rich Mesic Forest	S3	Edinger *et al*. 2002

Classification System	Community Name	Rank	Citation
Rhode Island Natural Heritage Program	Beech-Maple Forest	S2S3	Rick Enser pers. comm.
Pennsylvania			
Virginia	Rich Cove and Slope Forests		
West Virginia Natural Heritage Program	*Acer saccharum - Fraxinus americana - Tilia americana / Acer spicatum / Allium tricoccum - Caulophyllum thalictroides* Forest (CEGL005008)	S2S3	Jim Vanderhorst pers. comm.
Society of American Foresters	Sugar Maple–Basswood: 26 Sugar Maple: 27, Sugar Maple-Basswood-White Ash subtype		Eyre 1980
Ontario	Dry-Fresh Sugar Maple-Basswood Deciduous Forest Type or Moist-Fresh sugar Maple-Yellow Birch Deciduous Forest Type	S5?	http://.mnr.gov.on.ca/MNR/nhic/communities/comm_list_terrestrial.cfm#

DESCRIPTION OF COMMUNITY

Plant species

Canopy

The rich woods is typically a closed-canopy forest dominated by sugar maple (*Acer saccharum*), basswood (*Tilia americana*) and white ash (*Fraxinus americana*). Frequent associates include American Hop-hornbeam (*Ostrya virginiana*), red oak (*Quercus rubra*), American beech (*Fagus grandifolia*) and yellow birch (*Betula alleghaniensis*), American elm (*Ulmus americana*) and occasionally butternut (*Juglans cinerea*). The overstory is uneven aged and typically lacks signs of recent large-scale disturbance. In Vermont, sugar maple is the dominant canopy species in combination with basswood and white ash. Butternuts can be occasionally abundant (Thompson and Sorenson 2000). Sub-canopy species include striped maple (*Acer pensylvanicum*), and ironwood (*Ostrya virginiana*).

Shrubs

The shrub layer is often undeveloped (Species Viability Evaluation Expert Panel 2002), but can be well developed in areas receiving more light (Thompson and Sorenson 2000). It can be dominated by saplings of overstory species, but may include hobblebush (*Viburnum alnifolium*), alternate leaved dogwood (*Cornus alternifolia*) witch hazel (*Hammamelis virginiana*), red-berried elder (*Sambucus racemosa* ssp. *pubens*) and/or fly honeysuckle (*Lonicera canadensis*).

Herbs

The abundance of herbs found in the rich woods is probably the most distinguishing characteristic. Most species are perennial and a number of these are ephemeral; producing foliage and flowers before the canopy leafs out, senescing shortly thereafter. Table 2 lists the herbs and graminoids typical of the rich woods as described by the various community classification systems of nearby states.

Table 2. Indicator and characteristic species of the rich woods communities of New England.

Scientific Name	Common Name	NH *	ME †	VT ?	MA °
Actaea pachypoda	white baneberry				
Adiantum pedatum	maidenhair fern	✓	✓	✓	
Allium tricoccum	wild leek			✓	✓
Aralia racemosa	spikenard	✓			
Asarum canadense	wild ginger	✓	✓	✓	✓
Athyrium thelypteroides	silvery spleenwort	✓		✓	
Botrychium virginianum	rattlesnake fern	✓		✓	
Bromus pubescens	hairy wood brome-grass		✓		
Carex sprengellii		✓			
Carex alopecoidea	foxtail sedge		✓		
Carex blanda	bland sedge	✓			
Carex hirtifolia	pubescent sedge	✓			
Carex laxiflora	lax sedge	✓			
Carex leptonervia	faint-nerved sedge	✓			
Carex pedunculata	peduncled sedge	✓			

Scientific Name	Common Name	NH *	ME †	VT ?	MA °
Carex plantiginea	plantain-leaved sedge	✓		✓	✓
Carex platyphylla	flat-leaved sedge	✓			✓
Carex rosea	rosey sedge				
Carex sparganioides	bur reed sedge		✓		
Carex sprengelii	Sprengel's sedge			✓	
Caulophyllum thalictroides	blue cohosh	✓	✓	✓	✓
Cypripedium pubescens	large yellow lady's-slipper	✓			
Cystopteris bulbifera	bulbet fern			✓	
Deparia acrostichoides	silvery spleenwort		✓		
Dicentra canadensis	squirrel corn				
Dicentra cucullaria	Dutchman's breeches	✓	✓	✓	✓
Dryopteris felix-mas	male fern		✓		
Dryopteris goldiana	Goldie's fern	✓	✓		✓
Eupatorium rugosum	white snakeroot	✓		✓	
Geranium robertianum	herb Robert			✓	
Hackelia deflexa	American stickseed		✓		
Hepatica spp.	hepatica species			✓	
Hydrophyllum virginianum	waterleaf			✓	
Impatiens pallida	pale jewel-weed		✓	✓	
Laportea canadensis	wood nettle			✓	
Milium effusum	wild-millet	✓			
Oryzopsis racemosa	mountain rice	✓			
Osmorhiza claytonii	sweet cicely	✓			✓
Panax quinquefolius	ginseng	✓	✓		
Phegopteris hexagonoptera	broad beech fern		✓		
Polystichum acrostichoides	Christmas fern		✓	✓	
Rubus odoratus	purple flowering raspberry	✓			
Sambucus pubens	red-berried elder	✓			
Sanguinaria canadensis	bloodroot	✓			✓
Sanicula marilandica	black snakeroot			✓	
Solidago flexicaulis	zigzag goldenrod		✓	✓	✓
Viola canadensis	Canada violet	✓		✓	
Viola pubescens	downy yellow violet	✓			
Viola rotundifolia	round-leaved yellow violet		✓	✓	

* species of New Hampshire's Rich Mesic Hardwood Forest Sperduto (2000).
† characteristic species of Maine's Maple-Basswood-Ash Forest (Maine Department of Conservation, Natural Community Fact Sheet).
? abundant or occasional to locally abundant species of Vermont's Rich Northern Hardwood Forest (Thompson and Sorenson 2000).
° typical species of Massachusetts's Rich Mesic Forest Community (Swain and Kearsley 2000).

Animal species

Degraff and Yamasaki (2001) provide a complete list of animal species that use the rich woods for breeding and/or feeding. Table 3 shows animal species noted in Natural Heritage Program community descriptions for Massachusetts and Vermont.

Table 3. Animals of the rich woods.

Mammals		MA	VT
black bear	*Ursus americanus*		✓
masked shrew	*Sorex cinereus*	✓	✓
red-backed vole	*Clethrionomys gapperi*	✓	✓
Deer mouse	*Peromyscus maniculatus*		✓
white-footed mouse	*Peromyscus leucopus*		✓
woodland jumping mouse	*Napaeozapus insignis*	✓	✓
chipmunk	*Tamias striatus*		✓
flying squirrel	*Glaucomys sabrinus*	✓	
Grey squirrel	*Sciurus carolinensis*	✓	
Amphibians			
Northern redback salamander	Plethodon cinereus		
spotted salamander	*Ambystoma maculatum*	SC	✓
Jefferson salamander	*Ambystoma jeffersonianum*	WL	
eastern newt	*Notophthalmus v. viridescens*		✓
wood frog	*Rana sylvatica*		✓
northern two-lined salamander	*Eurycea bislineata*		✓
dusky salamander	*Desmognathus fuscus*		✓
spring salamander			✓
Four-toed salamander	*Hemidactylium scutatum*	SC	
Reptiles			
spotted turtle	*Clemmys guttata*	SC	
wood turtle	*Clemmys insculpta*	SC	
black rat snake	*Elaphe o. obsoleta*	E	
Invertebrates			
mustard white	*Pieris napi oleracea*	SC	
Birds			
wood thrush	*Hylocichla mustilena*		
veery	*Catharus fuscenscens*		
black-and-white warbler	*Mniotilta varia*		
ovenbird	*Seiurus aurocapillus*	✓	
Louisiana waterthrush	*Seiurus motacilla*		
scarlet tanager	*Seiurus noveboracensis*	✓	
barred owl	*Strix varia*	✓	

? species of Vermont's Rich Northern Hardwood Forest (Thompson and Sorenson 2000).

° species of Massachusetts's Rich Mesic Forest Community (Swain and Kearsley 2000). E= Endangered, SC = Special Concern, WL= Watch List

COMMUNITY ECOLOGY/ENVIRONMENTAL CONDITIONS

History

Because species that now belong to the rich woods were displaced during glaciation, some argue that their association is relatively new. "In the northern part of the deciduous forest region, climatic disruption during the Pleistocene and glacial modification of the soils have left a lasting impact on the forests...Evidence is accumulating that species which commonly occur together in the forest today were in widely separated refugia during full glacial time (Davis 1969). "Modern communities have been assembled by migration of species from these refugia only in the past few thousand years or even more recently in the north. Consequently, most of the species have been ecologically associated for only a few generations" (Hicks and Chabot 1985).

Landscape Position

Rich Mesic Hardwood Forests are distinguished by the nutrient availability of the soils on which they are found. The landscape positions of these communities often contribute to the nutrient enrichment of the soils. They are found where calcium rich or circumneutral bedrock is near the surface or on calcareous or circumneutral till. They are also found in colluvial situations where downslope movement of organic and fine mineral material collects such as concave hillsides, bases of ledges or slopes, talus slopes, ravines or drainages. These communities can also be found on moderate-steep grades.

Ledges, cliffs and talus in New Hampshire often occur on south and east aspects due to glacial "plucking" (Sperduto 2000). In the Green Mountains of Vermont, Smith (1995) found that communities with an overstory of maple, ash, basswood and beech are likely found on moderate slopes (17 +/- 8%), and have a NE to SE aspect. In Massachusetts these communities are found on north or east facing concave, middle to lower slopes (Swain and Kearsley 2000).

Elevation

The typic variant of the Rich Mesic Forest is found from about 500 (152 m) to 1800 ft (549 m). The High elevation variant extends from 1800 ft (549 m) to 2600 ft (792 m) (Sperduto 2000). This appears to be near the transition between northern hardwoods to boreal forests (primarily coniferous) that occurs at about 760 m (2493 ft) (Bormann and Likens 1979).

Leak (1978) found enriched sites between elevation 335 m (1099 ft) and 610 m (2001 ft) in the southeastern quarter of the White Mountain National Forest within feldspar rich granite-derived glacial drift.

In Massachusetts, Rich mesic forest communities are restricted to elevations below 2400 ft (732 m) (Swain and Kearsley 2000).

Low elevation rich sites are most likely to be disturbed for agricultural purposes, thus they are rare and threatened. Habitats for species such as *Eupatorium purpureum*, *Collinsonia canadensis* and *Pyrola chlorantha* that prefer these low elevation sites (Species viability Evaluation Expert Panel 2002) are thus limited, especially in the Green Mountain National Forest.

Soils
Sperduto (2000) describes the soils of the rich mesic forest as "generally deep, mesic and well drained, nearly stoneless to extremely gravelly/stony loams, very fine to medium sandy loams, and silt loams (all of variable depths)." The A horizon is often a deep mull (Sperduto and Engstrom 1995), rich in organic matter formed from rapid decomposition of leaf litter and humus. The pH of the upper B horizon ranges from 5.0 to 5.5 and is rich in N, Ca and other base cations (Sperduto 2000). Soil parent materials are generally more easily weathered and/ or have higher calcium concentrations than granite and include "schists and shales… and various syenites, diorite and perhaps gabbros" (Sperduto 2000). In New Hampshire, these parent materials are found in the western part of the state "within 25 miles of the Connecticut River, …north of the White Mountains, ... and at smaller isolated locations throughout the rest of the state … including the Saco and Swift River valleys, Kilkenny vicinity, Cherry Mt., Pawtuckaway Mts. and Rattlesnake Mts. (Sperduto 2000).

Enriched soils derived from granitic drift in the southwest quarter of the White Mountains National Forest "usually occur as coves or benches within areas of tills or occasionally compact tills. The distinguishing feature is organic matter or organic-coated fine material incorporated into the mineral horizons. Horizonization is poor. Drainage may be good to moderate or poor (Leak 1978). Eight out of nine sample points representing enriched habitats were found in well-drained to moderately well drained pan; Marlow-Peru very stony fine sandy loam association, sloping (Leak1982).

In Vermont, Fincher and Smith (1994) found that the hardwood community types of the Green and White mountains are broadly distributed among soil taxonomic units. Rarely are they found on lithic soils. Rich Northern Hardwood Forests soils range from well-drained to somewhat poorly drained. Some soils have a dense basal till 18 to 24 in below the surface that forms a restrictive horizon keeping moisture and nutrients near the surface (Thompson and Sorenson 2000). They are likely to be sandy loam to fine sandy loam in both the B and C horizon. They are typically on the mesic to wet and fertile to very fertile end of the spectrum and are characterized by deep A horizons (Smith 1995). Rolling terrain overtopping calcium rich bedrock can provide the nutrients this community needs (Thompson and Sorenson 2000)

Leaf and plant matter decompose rapidly in this community and results in deep soils "so that there is rarely more than one year's accumulation of leaves on the forest floor" (Swain and Kearsley 2000).

Nutrients
"Rich Northern Hardwood Forests are places where colluvial (downslope movement) or mineral rich bedrock, or some combination of the two, provide plants with a steady supply of nutrients" (Thompson and Sorenson 2000). They are usually found within the northern hardwood forest on the richer sites in coves or benches. These rich sites are the result of organic plant material accumulation on lower slopes or in gullies usually found downslope of calcium rich bedrock or till.

Youngberg (1951 in Curtis 1959) noted greater cation-exchange capacity of the soils of a maple-basswood stand compared to that of an adjacent mixed oak stand on the same soil

type. Total nitrogen, available phosphorus, and available potassium were also higher under the maple and basswood.

In an attempt to find out if herbs that are photosynthetically active in different seasons compete for nutrients, Rogers (1985) studied cover of herbs active during the spring and those active during the summer on the same plots. He did not find significant differences in herb cover for most species, suggesting a lack of competition for nutrients. He did, however, find that on plots where spring ephemerals (*Erethronium* and *Dicentra*) were luxuriant, a 50% decrease in cover of *Acer saccharum* and *Ulmus rubra* seedlings, suggesting at least the potential for herbs to affect the future canopy structure of the forest.

Light

Because of the deciduous nature of the rich woods, the amount of light available to understory species varies greatly be season. The herbaceous layer is predominantly made up of ephemerals. These plants take advantage of the intense spring sun and complete most of the active portion of their life cycle before the canopy leafs out completely. During clear days in the spring, temperatures can rise to 120° to 130°F within the leaf litter and appear to break the dormancy of leaf and flower buds of spring ephemerals (Curtis 1959).

Other herbs that are photosynthetically active and retain their foliage throughout the season are adapted to thrive in the low light conditions of the mesic hardwood forest. Randall (1952 in Curtis 1959) studied the chlorophyll content of a number of these species and found about twice the chlorophyll per milligram of dry matter as that of plants of dry open habitats.

Brewer (1980) found that species inhabiting long-undisturbed forests tended to be adapted to "seasonally-low light flux" while those that disappeared from the forest during his 50 years of study of a climax deciduous forest in Michigan tended to lack this adaptation. He attributes this change to three possible conditions. One is that "the year after year continuation of low light flux may lead to the slow extinction of some species." The other two conditions have to do with the increase of sugar maple in the canopy during the course of his study. He speculated that because sugar maple casts a denser shade than most other trees (Horn 1971) light levels became insufficient for some species. The third possible condition is that light patches provided by less shade tolerant trees like *Tilia americana* and *Fraxinus americana* that leaf out up to a month later than sugar maple have diminished with the importance of these species in the canopy. The result is conditions favorable for the earliest of spring ephemerals and others well adapted to very low light.

The canopy of the hardwood forest does not provide complete shade, but allows for penetration of sun flecks. In the mesic forest of Wisconsin, Curtis (1959) found that flecks average just under 2 m2 in size and moved constantly with the angle of the sun. At any one time the fleck provided light to slightly more than one percent of the forest floor.

Hicks and Chabot (1985) identify two general adaptive strategies for species of the deciduous forest: Avoidance and Tolerance. Spring ephemerals practice avoidance by timing their growth to take advantage of light, nutrient and water resources before canopy species become active for the season. These species are adapted to maximize photosynthesis during the time before leaf out and are limited from exploiting sites with reduced light. Other species practice avoidance of succession by capitalizing on relatively short-lived canopy gaps caused

by tree falls. Of the tolerant species are those adapted to resource limitations that can not be avoided by temporal or spatial adaptations. These are species that carry out most of their growth and photosynthesis under a closed canopy and include evergreen and semi evergreen species.

Moisture

Mesic conditions are a requirement for the rich woods. Herbs of the rich woods that are adapted to growing in the shade are also more sensitive to variable moisture. Curtis (1959) cites the work of Randall (1953) in which he investigated the water relations and photosynthesis of aestival species. Randall found that leaves of the herbs of shady mesic sites "could loose an average of only 3.6 percent of their turgid water content before showing visible signs of wilting" and subsequent growth cessation compared to herbs of a dry open oak woods that could sustain a 20 percent loss of turgid water before wilting. To illustrate the need for constant moisture Curtis (1959) states that in a drought period of even one week will greatly reduce the flowering populatio n of *Triphora trianthophora.*

Fire

Although less common than in the western states, natural fire has and will continue to be a factor in this community. In their study of the Psiga area, Cline and Spurr (1949) found evidence of fire on the trees and in the soil. They note evidence of a pine snag struck by lightning causing a fire that penetrated a foot below ground and surmise a scenario that such a snag could smolder for a few days after the storm and become the source of ground fire once the litter dries out sufficiently. They also note the presence of a group of several canopy trees killed from electrical shock creating a canopy opening.

Wind

Windthrow in this uneven age forest is an important source of light gaps. More intensive winds associated with storms, or microbursts, can drastically change the community structure especially if trees are previously weakened by fire or disease. Abrell and Jackson (1977) state that beech may be susceptible to windthrow, especially if nearby clearing intensifies wind effects. Under normal conditions, however, wind velocities measured in the mesic hardwood forests of have been found to be one tenth that of the velocity outside the forest (Curtis 1959).

Succession

The rich woods type is typically late successional (Thompson and Sorenson 2000, ME DOC, Natural Areas division) and is distinguished by a lack of recent, large scale, disturbance. Sugar maple is considered a tolerant species in that it can regenerate in the shade. Other canopy associates such as beech, and basswood are also tolerant and ash is considered intermediate (Baker 1970). Sugar maple, and beech are among the most important climax species in the Psigah virgin forest of southwestern New Hampshire, white ash and basswood are also considered climax species by Cline and Spurr (1942) who estimated that these species achieve dominance 300 – 400 yrs after major disturbance. Climate, history, seed sources, and site conditions will determine how long it will take a previously disturbed site to acquire the characteristics of the rich woods (Thompson and Sorenson 2000).

In a study of an Appalachian old-growth forest in North Carolina over a period of 15 years including a five year severe drought, Olano (2002) found that sugar maple basal area

increased and basswood and beech basal decreased proportionately. Tree mortality was lowest among sugar maple, and decreased as diameter size class increased. Tree mortality was highest among basswood and beech, specifically, the smallest and largest diameter trees were affected. Beech mortality was highest in all diameter size classes. One explanation for these results is that sugar maple is more drought resistant and resilient (Olano 2002, Parshall 1995).

A similar trend was observed in an old-growth beech-maple forest in Indiana in the absence of drought. The basswood in this forest showed an increase in basal area, but not as large an increase as the sugar maple (Abrell and Jackson 1977).

Forests where natural or human disturbances have created large openings will look quite different in species composition from the rich woods. Disturbed forests may be dominated by a combination of sugar maple, bigtooth aspen, white ash, striped maple, black cherry, white pine, yellow birch, and pin cherry (Thompson and Sorenson 2000).

The herbaceous species that define this community are generally not found in regenerating young stands. The understory conditions of mature hardwood stands offer unique growing conditions for herbaceous species. Because the mature trees of these communities leaf out relatively late in the spring, ephemeral herbs experience intense light, and high ground temperatures during their peak growing season. After leaf out, the understory becomes deeply shaded and thus resists invasion by species that require higher levels of light later in the growing season (MacDougall and Loo 1988, Duffy and Meier 1992).

Species inhabiting the rich woods have life histories that indicate their adaptation to stable habitats. Demographic characteristics such as "low seedling recruitment and establishment rates, ... relatively long pre-reproductive period (>/= 3years), slow individual growth rate, greater longevity of established individuals and stable population growth rate" are cited as adaptations for life in a stable habitat (Charron and Gagnon 1991). *Panax quinquefolius* is one such species (Charron and Gagnon 1991).

Triphora trianthophora is relatively uncommon and found only in the best-developed and least-disturbed mesic hardwood forests of southern Wisconsin (Curtis 1959).

Gap Dynamics

Most of the species of concern in the rich northern hardwood forest need only natural, local scale, gap formation and closure found within a multi-age stand (Species Viability Evaluation Expert Panel 2002). In their study of a mature beech-maple forest in Ohio, Moore and Vankat (1986) found that gaps "did not alter spring environmental conditions, but produced increased solar radiation and soil moisture in summer after canopy closure." They found that "herb species richness was largely unaffected by gap dynamics; however, total herb cover increased with gap formation and decreased with canopy redevelopment." The change in herb cover was the result of increases in annual herbs (*Impatiens pallida* and *Pilea pumila*) that prefer increased moisture due to the lack of canopy interceptance. In contrast, cover of the spring ephemeral, *Dicentra canadensis* decreased in newly created gaps (1-2 yrs old) and middle aged gaps (5-7 yrs old), but found its highest cover in old gaps (12-15 yrs old).

Moore and Vankat(1986) suggest that the rapid colonation of gaps by herbs such as *Impatiens pallida*, *Pilea pumila* and *Osmorhiza claytonii* serve to conserve nutrients of the rich woods that might otherwise be leached from the system because of to the greater throughfall of precipitation and the lack of large roots capable of taking up nutrients.

In the Warren Woods of Michigan, Brewer (1980) concludes that gap phase regeneration was not a factor in increasing diversity of the forest as the gaps created by wind throw filled with sugar maple seedlings to the exclusion of herbs. He did find that *Phytolacca americana* (pokeweed) and the shrub *Sambsus pubens* (red-berried elder) flourished for a few years following the wind-throw in the newly created pit and mound habitat.

Microsite Topography

Variations in microsite topography provide substrate and environmental conditions that promote diversity. In her study of microtopography and seasonal change in a species-rich cove hardwood forest of the Great Smokey Mountains, Bratton (1976) concluded that "Herbaceous species respond strongly to difference in microtopography and that these differences should be related to species responses along major gradients. The patchiness of the forest- floor environment encourages a high diversity of smaller plant species and has probably been a major force in the evolution of morphological diversity among the different herbaceous species and genera." "Microtopography and seasonal change are responsible for much of the niche differentiation between the herbs and thus largely account for the species diversity of this rich herb stratum."

In a comparison of composition and structure of old-growth and both managed and unmanaged second growth forest by Crow et al. (2002), the old-growth was found to be more diverse in structure with multistoried canopies, more canopy gaps having greater variation in size and shape, and greater structural heterogeneity in the understory. Forest floor features such as pit and mound microtopography and large woody debris were also more characteristic of the old-growth. The diversity provided by the canopy and microtopography of the forest floor resulted in greater variation in the richness of the understory.

Patch size

Because species composition varies within the rich woods and the edaphic limitations of the community type, patch size alone may not be a good indicator of herbaceous species diversity (Ford et al. 2000). Stand basal area, percent canopy cover, extent of connected habitat and area of habitat within 1km of the target stand were all found to be important in predicting species richness, diversity and evenness in the cove-hardwood forests of the southern Appalachians (Ford et al. 2000).

Table 4 summarizes the habitat requirements of the rich woods Regional Forester Sensitive Species.

Table 4. Summary of Regional Forester Sensitive Species habitat associations.

Species	Stand Age	Location in Stand	Stand size	Elevation	Forest structure	Shrub layer	Ground cover	Features
Blephilia hirsuta	Unknown	Forest interior (?)	Unknown	<1500'	>60% canopy closure	Inter-mediate	Herbs/Forbs	Unknown
Carex aestivalis	Late successional Mature	Forest interior Opening interior	Unknown	<2500'	Main canopy layer	Unknown	Unknown	Bedrock outcrops Cobbles Benefits from wind disturbance
Carex baileyi	Unknown	Forest interior Aquatic-terrestrial edge Opening interior	Unknown	Unknown	Unknown	Unknown	Unknown	Near water
Collinsonia canadensis	Unknown	Variable	Unknown	<1500'	Main canopy layer >60% canopy closure	Unknown	Unknown	Sand and clay soils of moderate permeability
Cypripedium parviflorum var. *pubescens*	Variable	Forest interior Aquatic-terrestrial edge Opening-forest edge Opening-interior	Unknown	Unknown	>30% canopy closure	Sparse	Unknown	Near water Sand or Loam soil of moderate to slow permeability pH 6.6-8.4
Dicentra canadensis	Variable	variable						

Species	Stand Age	Location in Stand	Stand size	Elevation	Forest structure	Shrub layer	Ground cover	Features
Dryopteris filix-mas	Old growth ? Late successional? Mature	Unknown	Unknown	No preference	Main canopy & Ground cover >60% canopy closure	Unknown	Unknown	Limestone rock Ledges, glades and slopes pH 6.6-7.3
Dryopteris goldiana	Old growth Late successional (P) Mature Variable	Forest interior (?) Variable	Unknown	<1500 - >3500’	Main Canopy	N/A	Herbs/Forbs Moss/ Lichen	Cavities Caves
Eupatorium purpureum.	Unknown	Forest interior Opening-forest edge Shrubland-forest edge	Unknown	<1500’	>30% canopy closure	Unknown	Unknown	Boulders Loam ? Rapid or Moderate permeability pH 6.6-7.3
Juglans cinerea	Variable	Opening or edge						
Osmorhiza berteroi	Old growth Late successional Mature	interior (P) Opening-forest edge	No preference	<1500-2500’	>60% canopy closure	Dense Intermediate	Intermediate	
Panax quinquefolius	Old growth Late successional Mature	interior (P)	1-10 acres	<1500-2500’	>60% canopy closure	Deciduous Dense	Unknown	

Species	Stand Age	Location in Stand	Stand size	Elevation	Forest structure	Shrub layer	Ground cover	Features
Petasites frigidus var. *palmatus*	Variable	No preference	Unknown	No preference	Unknown	Unknown	Herbs/Forbs Moss/ Lichen	Near water
Phegopteris hexagonoptera	Variable	Unknown	Unknown	<3500'	Unknown	Unknown	Unknown	Rocky forest
Platanthera orbiculata	Variable	Unknown	Unknown	<2500'	Unknown	Sparse Absent Unknown	Sparse Absent	Unknown
Pyrola asarifolia	No preference	Forest interior Aquatic-terrestrial edge (P) Opening-forest edge	No preference	<1500' (P)	<30% canopy closure	Intermediate Sparse	Intermediate Sparse	
Pyrola chlorantha	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	
Triphora trianthophora	?	?		<1500'	Filtered light Shaded	Sparse	Sparse	Hollows filled with deep leaf litter, close association with *Fagus grandifolia*
Uvularia perfoliata	Unknown , benefits from wind and Insect, disease infestations	Forest interior Opening-forest edge Opening interior	Unknown	<2500'	<60% canopy closure	Unknown	Unknown	Sand or loam soils Moderate permeability pH 5.1-8.4,

Compiled from individual species conservation assessments.

Reproduction and Seed Dispersal

After studying the life histories of herbs of the deciduous forest, Bierzychudek (1982) made the following generalizations: "Most have a long juvenile period and an extended reproductive life, vegetative as well as sexual reproduction, and produce a few, relatively heavy, seeds each season that are dormant for a few months or not at all. Mortality of seedlings and young plants is high, but decreases once plants reach adulthood and remains low and more or less constant for large plants."

A period of exposure to moisture and cold is required for germination of seed of most of the rich woods species. Some require two winters before a seedling breaks the soil surface. "The first winter breaks the dormancy of the hyptocotyl and allows a root system to develop during the following summer while a second winter is needed to permit the epicotyl to grow into an aerial stem" (Curtis 1959). *Uvularia perfoliata* is an example of the latter type of germination (Wihgham 1974 in Bierzychudek 1982).

Species that primarily reproduce by asexual means are less likely to colonize new habitat than species that are reproduce by sexual means. Among species that reproduce primarily by sexual means, the mechanism for seed dispersal is can limit the ability of a species to colonize new habitat. Table 5 shows the primary means of reproduction for the species of concern. In his study of Quercus dominate mixed–hardwood forests of southeastern Pennsylvania, Matlack (1994) found that "ant dispersed species migrated slowly and did not cross unforested areas to disjunct stands." Likewise, wind-dispersed species migrated relatively slowly, consistent with the low wind speeds encountered in closed-canopy forests (Geiger 1957 in Matlack 1994). Species with propagule that was ingested or adhesive were relatively successful at recolonizing new stands, however, there was a wide range of variation that Matlack attributes to the ranges and habits of the animal vector.

Table 5. Summary of Regional Forester Sensitive Species reproductive methods.

Species	Primary means of propagation	Bloom Period	Pollinators	Dispersal	Mycorrihiza	Notes
Blephilia hirsuta	sexual	mid July – mid August	bees likely (SVEEP 2002)	gravity/wind?		
Carex aestivalis	likely sexual	May		gravity/wind?		Fruits mid June – August
Carex baileyi	presumed sexual	late spring		wind/gravity?		Low seed abundance
Collinsonia canadensis	sexual	July – September	bees probable (SVEEP 2002)	gravity/wind?		
Cypripedium parviflorum var. *pubescens*	asexual	May-June	insects	gravity/wind?	✓	
Dicentra canadensis	both	late April – mid May	ants are likely	gravity/wind?		Hermaphrodite, self incompatible
Dryopteris filix-mas	sexual	spores mature July – August		wind		
Dryopteris goldiana	both	sori apparent July – August				Known to hybridize with *D. intermedia, D. marginalis, D. carthusiana, D. clintoniana,* and *D. ludoviciana* (Werth 1991, Haines and Vining 1998).
Eupatorium purpureum	sexual	July – September		wind		
Juglans cinerea	sexual	April - June		gravity squirrels rodents		Monoecious, flowers of both sexes do not usually mature simultaneously on any individual tree

Species	Primary means of propagation	Bloom Period	Pollinators	Dispersal	Mycorrihiza	Notes
Osmorhiza berteroi	sexual	June				
Panax quinquefolius	sexual	early summer 2-3 weeks		gravity/ingestion by small mammals, turkey and/or grouse		Polygamodioecious (Fryxell 1957 in Bierzychudek 1982)
Petasites frigidus var. *palmatus*	both	April – June		wind		Mostly dioecious
Phegopteris hexagonoptera	both					
Platanthera orbiculata		early–mid June – mid August			✓	
Pyrola asarifolia	asexual	mid May – mid July				
Pyrola chlorantha	sexual	mid June – mid July			possible (SVEEP 2002)	
Triphora trianthophora	both	late summer – fall	bees? *Bombus*/ *Hylaens*	wind likely	✓	
Uvularia perfoliata	both			insect		Flowers in gaps. Low seed production. Hermaphrodite, mostly self-incompatible (Bierzychudek 1982)

Compiled from individual species conservation assessments.

Curtis (1959) lists reproduction rates of herbs of the mesic forest showing seeds per flowering plant per year and estimated percentage of seeds that will produce seedlings each year (from Archbald 1950 and Struik 1957).

Species	Seeds/Plant/Year	Estimated Success (percent)
Dicentra cucullaria	14	1.79
Caulophyllum thalictroides	7	4.28
Sanguinaria canadensis	25	.54
Allium tricoccum	15	1.33

This information was not available for Regional forester Sensitive Species, however, Charron and Gagnon (1991) provide similar information on *Panax quinquifolius.*

Viburnum alnifolium (hobblebush) is occasionally an important component of the shrub stratum. For this species "invasion of new areas is by the chance, long distance dispersal of seed by small mammals. Local spread by means of basal sprouting and the layering of prostrate branches eventually allows *Viburnum alnifolium* to dominate a site once it has been established. A variety of factors, including a paucity of flowers and fruit under closed-canopy conditions and frost damage in openings, however, limits hobblebush's production of seed and thus its potential for long-distance dispersal by seed" (Rollins 1974 in Whitney and Foster 1988).

RANGE OF NATURAL VARIABILITY: COMMUNITY DISTRIBUTION AND CONDIDTIONS

The most widespread forest type in the North is the maple-beech-birch forest type covering 54 million acres and accounting for 31% of all northern forests (Smith et al. 2001). The rich woods are usually found in small patches throughout this large area of maple-beech-birch forest.

The rich woods association "ranges generally from Ontario and New England west to Michigan and south to New Jersey and New York with a discontinuous southward extension in the High Allegheny Mountains to western Virginia and eastern West Virginia" (NatureServe 2002). It "has a wide geographic distribution, but is locally distributed within its range due to specific requirements for mesic sites with fertile soils. In gentler topographic regions, many examples of this community have probably been destroyed for agriculture, and most remaining examples elsewhere have been altered by past logging. Consequently much of the remaining acreage is of variable quality" (NatureServe 2002). However, many of the species that inhabit this forest type can maintain reproducing populations in small patches less than an acre in size (Species Viability Evaluation Expert Panel 2002).

New Hampshire
Soils in the White Mountains "developed in glacial till or outwash laid down during the Wisconsin age." Rocks in the soil and on the surface "are granitic and contain orthoclase feldspar, quartz, muscovite mica, biotite mica and small amounts of other minerals. These minerals weather slowly and have produced coarse-textured sand soils of low fertility" (Hoyle 1973). Soils are, in general, very acidic (below pH 5.5). Hoyle states that humus is the main source of nutrients indicating that rich woods of the White Mountains rely mainly on landscape position to provide the influx of nutrients necessary for their existence and survival. As a result, the rich woods exist only in patches within a matrix of much poorer soils.

Leak (1982) found that in the Bartlett Experimental Forest, that enriched habitats usually occur at the slope break between the upper and lower elevations. In addition, areas of alluvial soils adjacent to major streams were also typed as enriched. In total, enriched habitats represented only 0.9% of the land area.

The Natural Communities of New Hampshire: A guide and classification (Sperduto 2000) classifies several communities and variants under the title "Enriched forests on till, terrace and talus soils." The primary community of concern here is the Rich mesic forest (B2b). Some of the Regional Forester species are listed, however, as members of similar communities and community variants. The Semi-rich mesic sugar maple-beech forest (B2a) which is considered an "intermediate between typical sugar maple-beech-yellow birch forests and rich mesic forests in terms of nutrient availability, productivity and possibly moisture availability" may contain *Panax quinquefolius*. The High elevation fern-glade variant (B2a2) of this semi-rich forest has a historic record for *Osmorhiza berertoi*. *Pyrola asarifolia* is listed as potential rare species of the sugar maple-yellow birch-white ash/hazlenut-dogwood terrace flat variant (B2a3) of the semi-rich forest. The High elevation variant (B2b2) of the Rich mesic forest from 1800 ' ranging to 2600 ' elevation is known to contain *Osmorhiza berteroi* (Sperduto 2000).

In their comparison of species diversity in northern hardwood forest of Hubbard Brook watershed 6 to two forested areas of the Green Mountains, four other mountain slopes in Vermont, and one stand in the White Mountains, Siccama et al. (1970) found that the stand from the White Mountains was the least enriched in the comparison. They differentiate the two Green Mountains sites (Gifford Woods and Camels Hump) from the others by their mull soils (indicative of higher base saturation) compared to the mor soils of the other stands. They conclude that, based on species richness, soil conditions and stream water chemistry, Hubbard Brook is at or near the oligotrophic end of the scale of northern hardwood forests.

Vermont
Unlike New Hampshire, the rich northern hardwood forest habitat is fairly abundant in Vermont and can occur in large patches due to the greater abundance of calcium rich bedrock.

Thompson and Sorenson (2000) describe the natural communities of Vermont. Of primary concern here is their Rich northern hardwood forest. Several of the Regional Forester species are listed as members of related communities. *Dryopteris goldiana* is

also listed as a species of the Northern hardwood talus woodland and the Transition hardwood talus woodland. A number of species are members of the Mesic red oak-northern hardwood forest in addition to the Rich northern hardwood forest. These species include *Panax quinquifolius* and *Phegopteris hexagonoptera*. Only *Carex aestivalis* is listed only with Red oak northern hardwood forest.

Smith (1995) used canonical correspondence analysis in an effort to identified ecological types and species groups of the upland northern hardwood communities of the central Green Mountains, VT. Two community types identified in this study correspond to the rich northern hardwood forest discussed here. The *Acer/Arisaema* group is located "on mid-slopes of gentle topography characterized by soils of sandy loam or finer texture underlain by a compact basal till layer at an average depth of 60cm. This layer serves to restrict water movement and favors the accumulation of transported material." Thus, creating "moist to very moist and fertile to very fertile conditions." The similar *Acer/Osmorhiza* (*claytonii*) group is found on "fine textured soils and occur(s) on long linear lower and toe slopes (cove positions) associated with compact tills. These sites often have deep A horizons indicative of enrichment from upslope (Leak 1982)." The result in this case is "moist to very moist sites and fertile to very fertile conditions."

Massachusetts

Swain and Kearsley (2000) define a single Rich, mesic forest community that parallels the rich woods community discussed here. Bellemare (2002) used a cluster analysis to divide the Rich mesic forests of Massachusetts into two major groups; the *Dicentra-Polystichum* Association (DPA), and the *Allium-Caulophyllum* Association (DCA). He further divides DPA into two additional classes; one that is distinguished by high frequencies of *Viola blanda* and *Viola rotundifolia* (1A) and the other characterized by the abundance of *Caulophyllun thalictroides*, *Adiantum pedatum*, *Impatiens* spp., *Carex plantaginea* and *Athyrium thelypteriodes* (1B). Differences in habitat features were also noted (Table 6). Among the Regional Forester species *Dicentra* spp. were the most abundant species in the understory of the DPA. *Panax quinquifolius* also had a higher frequency in the DPA. *Dryopteris goldiana* had a higher frequency in the ACA association. but was also well represented in the DPA class 1B.

Table 6. Generalized conclusions from Bellemare (2002).

	ACA	DPA class 1A	DPA class 1B
Vegetation	highest herb layer cover	lowest herb layer cover	intermediate herb layer cover
Soil nutrient level	highest nutrients	lower nutrients	high nutrient
Soil pH	high pH	lower pH	high pH
Insolation	high, more southerly aspects, frequent bedrock exposures	lower	lower
Physiographic Limitations	Most limited, found on relatively steep, southeast to south facing slopes, mesic, calcareous soils, and frequent bedrock outcrops	More widespread, found on a variety of mesic, enriched soils	Limited by requirement for nutrient-rich, calcareous soils
Past land use impact	less past impact	? impact	greatly impacted
Conservation Priority	1	3	2

New Brunswick
MacDougall (2001) and MacDougall and Loo (1998) have extensively studied the rich hardwoods of the Saint John River valley. Distribution of stands was "concentrated below the Kintore Hill formation between Woodstock and Florenceville." Although rich soils were evident north of this area, MacDougall (2001) attributes the lack of this community type to climate and also, perhaps, topography. The southern limit is explained by the lack of calcareous parent material as well as human disturbance for agriculture and flooding by a hydroelectric dam upstream from Fredrickton. The current extent of this community is estimated to be less than one percent of its original extent owing to extensive land clearing (MacDougall 2001). "The distribution of rich woods sites in eastern Aroostook County, Maine is less well known than in New Brunswick. Only a few scattered locations have been discovered by botanists, reflecting higher and more intensive levels of disturbance of hardwood forest in Maine, as well as less systematic and intensive survey efforts (Sally Rooney, pers. comm.)" (Macdougall and Loo 1998).

Stands that contain seeps are more likely to contain rare species. MacDougall (2001) attributes this to concentration of solublozed mineral nutrients at these locations, but he also notes the prevalence of *Juglans cinerea* and *Tilia americana* and suggests that since both species leaf out later than other canopy species, that vernal light may also be a factor.

Wisconsin, Michigan, Minnesota
Rogers (1981) found that the southeastern part of Wisconsin and southern part of Michigan support the *Acer saccharum-Tilia americana* community, but further westward, the co-dominant becomes *Fagus grandifolia*. While *Acer saccharum* was dominant in the subcanopy east of this "beech border" having over 20 times more stems than *Tilia*

americana, it was les than three times more abundant than *Fagus grandifolia* in the subcanopy west of the border. Cover and frequency of the most common species did not differ with the change in canopy dominants on either side if the border, however, herb species richness was more variable east of the border and these stands contained a greater proportion of rare species. *Collinsonia canadensis* had a 60 percent presence in southern Michigan and *Panax quinquefolius* was noted as a rare species in the study.

Ontario

Lemieux (1963) describes the *Tilio-Aceretum sacchari* association of Quebec that includes *Dicentra canadensis* among the vernal herbs in his identification of ecosystem types. The type is found on mesic sites below 700 ft elevation on mull soils.

The vegetation of Mont St. Hilaire, Quebec was described by Maycock (1961). Although the paper did not take a community approach, it seems clear that elements of the rich woods are found here. It is possible that within the *Acer-Fagus* or *Fagus Acer* dominated stands, pockets of rich woods can be found. *Tilia americana* is "found predominantly in mesic, wet-mesic, and dry-mesic types" and is described as common. *Juglans cinerea* is found among other species in moist depressions and where seeps lie near the surface. *Dicentra canadensis* is described as widespread on St. Hilaire. *Dryopteris goldiana* and *Cypripedium calceolus* var. *parviflorum* are listed as rare, and other herbaceous elements of the rich woods are listed as common, (*Allium tricoccum*, *Caulophyllum thalictroides*, *Adiantum pedatum*) or infrequent to uncommon (*Carex plantaginea*, *Carex playtphylla*, *Asarum canadense*, and *Actaea pachypoda*)

CURRENT COMMUNITY CONDITION, DISTRIBUTION AND ABUNDANCE

Global Distribution

In the United States the *Acer saccharum-Fraxinus americana-Tilia americana/Acer spicatum/Allium tricoccum-Caulophyllum thalictroides* Forest community is found in CT, MA, MD:?, ME, MI, NH, NJ, NY, PA:?, RI, VA, VT, WV. In Canada it is found in the Province of Ontario (Association for Biodiversity Information (ABI) database (www.natureserve.org)). "This forest association ranges generally from Ontario and New England west to Michigan and south to New Jersey and New York, with a discontinuous southward extension in the high Allegheny Mountains to western Virginia and eastern West Virginia" (Nature Serve 2002).

STATUS AND DISTRIBUTION (Natureserve 2002)

Division: Warm Continental Division

Section Name	Occurrence Status
Maine & New Brunswick Foothills & Central Lowlands Section	Confident or Certain
Central Maine Coastal & Interior Section	Confident or Certain
St. Lawrence Valley Section	Possible
Northern Glaciated Allegheny Section	Confident or Certain
Northern Great Lakes Section	Predicted or Probable
Southern Superior Uplands Section	Predicted or Probable

Province: Laurentian Mixed Forest Province
Division: Warm Continental Regime Mountains
Province: Adirondack-New England Mixed Forest-Coniferous Forest-Alpine Meadow

Section Name	Occurrence Status
White Mountains Section	Confident or Certain
New England Piedmont Section	Confident or Certain
Green, Taconic, Berkshire Mountains Section	Confident or Certain
Adirondack Highlands Section	Confident or Certain
Catskill Mountains Section	Confident or Certain
Tug Hill	Predicted or Probable

Regional Distribution

New Hampshire

The rich woods of New Hampshire are largely concentrated in Coos and Grafton County (Table 7).

Table 7. Element occurrence of Rich mesic forest in New Hampshire.

Town	County	sites	Town	County	sites
Albany	Carrol	2	Landaff	Grafton	1
Barrington	Stafford	1	Littleton	Grafton	1
Bartlett	Carrol	1	Lyme	Grafton	3
Benton	Grafton	4	Milton	Strafford	1
Clarksville	Coos	2	Northumberland	Coos	1
Columbia	Coos	1	Pittsburg	Coos	1
Gorham	Coos	1	Plainfield	Sullivan	1
Hadleys Purchase		1	Sanbornton	Belknap	1
Hanover	Grafton	1	Stark	Coos	2
Hebron	Grafton	1	Stewartstown	Coos	4
Jackson	Coos	1	Success	Coos	1
Lancaster	Coos	2	Warren	Grafton	5

From New Hampshire Natural Heritage Inventory 2002

Maine

The Maple-basswood-ash forest type "is found throughout central and northern Maine, but the majority of known sites are concentrated in the western mountain region of the state. They typically occur as small patches of a few acres within a larger matrix of northern hardwood forests" (MEDOC Natural Areas Program).

Table 8. Element occurrence of Maple-basswood-ash forest in Maine.

Town/location	County	Sites
Squa Pan Township Squa Pan	Aroostoock	1 site
Casco	Cumberland	1 site
Falmouth	Cumberland	1 site
Farmington	Franklin	1 site
Strong, Avon	Franklin	1 site
Winthrop, Wayne	Kennebec	1 site
Batchelders Grant Evans Notch Hastings Mountain	Oxford	White Mountains National Forest . 2 sites total.
Stoneham Miles Notch	Oxford	White Mountains National Forest
Mason Township Haystack Notch	Oxford	White Mountains National Forest, Haystack Mountain, 7 acre stand Registered critical area #51 for rare plants. 3 sites total.
Greenwood	Oxford	3 sites
Albany Township Albany Mountain	Oxford	3 sites, Albany Mountain site in White Mountain National Forest
Canton	Oxford	
Sumner	Oxford	2 sites total
Woodstock Little Concord Pond	Oxford	3 sites total
Milton Township	Oxford	1 site
Bowmantown Township	Oxford	4 sites total
Bowmantown/Oxbow TWP	Oxford	1 site
T8 R10 Wels Big Reed Pond	Piscataquis	1 site
Dover-Foxcroft	Piscataquis	1 site
Skowhegan	Somerset	1 site
Parsonsfield	York	1 site
Cornish	York	1 site

From the Maine Natural Areas Program June 2002.

Vermont

Because of the abundance of rich woods habitats in Vermont, the Vermont Natural Heritage Program does not list all known occurrences. A thorough survey of the state has yet to be done. The data obtained includes just a sample of this community type in the state (Table 9).

Table 9. Occurrence of Rich northern hardwood forest in Vermont.

Town	County	sites	Town	County	sites
Leicester	Addison	1	Westford	Chittenden	1
Salisbury	Addison	1	Georgia	Franklin	1
Bennington	Bennington	1	Irasburg	Orleans	1
Manchester	Bennington	2	Brandon	Rutland	1
Peru	Bennington	1	Chittenden	Rutland	1
Peacham	Caledonia	1	Sherburne	Rutland	1
Colchester	Chittenden	1	Ponfret	Windsor	1
Milton	Chittenden	1	Woodstock	Windsor	1
Richmond, Jericho	Chittenden	1			

From Vermont Nongame and Natural Heritage Program September, 2002.

Global Rank

Global ranking for the community is G4: "This community has a wide geographic distribution, but is locally distributed within its range due to specific requirements for mesic sites with fertile soils. In gentler topographic regions, many examples of this community have probably been destroyed for agriculture, and most remaining examples elsewhere have been altered by past logging. Consequently much of the remaining acreage is of variable quality" (www.natureserve.org).

State Rank

RANKED AS S1, S2 or LISTED as T or E by State	RANKED AS S3-S5 OR S?	RANKED as SR or SRF	RANKED as SH or SX
	New Hampshire S3 52 occurrences		
	Vermont S4 ? occurrences		
	Maine S3 36 occurrences		
	Connecticut S2? *** Massachusetts S3 Michigan S3?/S4 New York S3 New Jersey S3 Pennsylvania Rhode Island S2-S3* Virginia West Virginia S2 or S3**		
	Ontario S5 Quebec New Brunswick Nova Scotia		

* Rick Enser pers. comm.

** Jim Vanderhorst WV Division of Natural Resources pers. comm.

*** Kenneth Metzler CT State Geological & Natural History Survey of Connecticut, Department of Environmental Protection pers. comm.

Northern New England Status (New Hampshire, Maine, Vermont):

	State rank	# of state occurrences		WMNF occurrences		GMNF occurrences	
		Total	Historic	Total	Historic	Total	Historic
New Hampshire	S3	52		9?			
Maine	S3	35		7?			
Vermont	S4	?				?	?

REGIONAL FORESTER SENSITIVE SPECIES ASSESSMENT TABLE

Table 10. Species occurrence by geographic area.

Species	New Hampshire		Maine		Vermont	
	TOTAL	WMNF	TOTAL	WMNF	TOTAL	GMNF
Blephilia hirsuta	0	0	0	0	1(1)	1
Carex aestivalis	1(2)	0	0	0	7(1)	2(1*)
Carex baileyi	2(4)	0	(4)	(1)	12	0
Collinsonia canadensis	0(2)	0	0	0	6(7)	0-1(0-1)
Cypripedium parviflorum var. *pubescens*	8(10H)	~1	13+	0	40	2
Dicentra canadensis	17(10)	5	5(2)	2	12+	0
Dryopteris filix-mas	N/A	N/A	1(1)	0	19(8)	2
Dryopteris goldiana	17(12)	3(1)	13(7)	1	9+	13+(1)
Eupatorium purpureum	8?	0	0	0	11	1
Juglans cinerea	present	present	present	present	present	?
Osmorhiza berteroi	0(15)	(7)	13(14)	1(1H)	0(1)	0
Panax quinquefolius	27(13)	12(3)	26(9)	5	44(2)	2
Petasites frigidus var. *palmatus*	2(4)	1	11+	0	6?	0
Phegopteris hexagonoptera	N/A	N/A	10(16)	0	11(18)	1(2)
Platanthera orbiculata	N/A	N/A	N/A	N/A	~30	8(5)
Pyrola asarifolia	2(7)	1	23(1)	0	11(15)	0
Pyrola chlorantha	8	0	16	?	1(1)	(1)
Triphora trianthophora	10(11)	3	7	3	4(3)	0
Uvularia perfoliata	2	0	(1H)	0	7(4H)	2,4*

Compiled from individual species Conservation Assessments. Often the numbers presented on the tables in the document differed from those within the text. I tried to use the best information presented. The numbers in parentheses indicate the number of historic occurrences. These numbers are not included in the totals.

* indicates that the species occurrence is within the forest proclamation boundary

+ indicates that the number of occurrences is a low estimate, based only on the number of counties for which the species has a record

POPULATION VIABILITY

Individual species Conservation Assessments include information about species viability. Table 11 summarizes the Regional Forester Sensitive Species State and Forest conservation status

Table 11. Conservation status of Regional Forester Sensitive Species.

Species	NH State Rank	ME State Rank	VT State Rank	MA State Rank	NY State Rank	White Mountain National Forest	Green Mountain National Forest
Blephilia hirsuta	N/A	N/A	S1,T	S1	SR		
Carex aestivalis	S1	N/A	S1,E	SR	SR		Sensitive
Carex baileyi	S1S2,T	SH,SC	S4	S1	SR	Sensitive	
Collinsonia canadensis	SH	N/A	S1	SR	SR		
Cypripedium parviflorum var. *pubescens*	S2	S?	S3				Sensitive
Dicentra canadensis	S2S3,T	S1,T	S4	SR	SR	Sensitive	
Dryopteris filix-mas	SR	S1,E	S2,T				Sensitive
Dryopteris goldiana	S2,T	S2	S4	S4	SR	Sensitive	
Eupatorium purpureum	SR	SR	S2	SR			Sensitive
Juglans cinerea	S1	SU	S2	S4	S4	Sensitive	Sensitive
Osmorhiza berteroi	SH,E	S2,T	SH			Sensitive	
Panax quinquefolius	S2,T	S2,E	S2S3	S3	S4	Sensitive	Sensitive
Petasites frigidus var. *palmatus*	S1,E	SR	S1,T	S1	S1	Sensitive	
Phegopteris hexagonoptera	SR	S2,SC	S2	SR	SR		Sensitive
Platanthera orbiculata	SR	SR	SR	S?			Sensitive
Pyrola asarifolia	S2,E	S3,SC	S2S3, T	S?	S2	Sensitive	
Pyrola chlorantha	SR	SR	SR	SR	SR		
Triphora trianthophora	S2,T	S1,T	S1,T	S1,E	S1S2, E	Sensitive	
Uvularia perfoliata	S1	SH	S2	SR	S?		Sensitive

Compiled from individual species Conservation Assessments.

COMMUNITY VIABILITY

Overstory species

Establishment and maintenance of the overstory species are limited by soil conditions (Leak 1978, Leak 1982, Fincher and Smith 1994, Biglow and Canham 2002), elevation (Solomon and Leak 1994, Siccama et al. 1970), climate (MacDougall 2001), and land use history (Bellemare 2002) among other factors. Typically the overstory species of this community are considered "tolerant" meaning that they can germinate and grow beneath a shaded canopy. Because of this, they are sometimes considered climax species Cline and Spurr (1942).

The rich woods is typically a mature, multiaged stand that has been free from large scale disturbance in recent history. "Wind is perhaps the commonest cause of death of overmature trees" Cline and Spurr (1942). "Storms of unusual violence may at times prostrate the larger part of a stand on an exposed site...Once a few trees are felled on the windward side, their immediate neighbors are exposed." While such wind damage is most common on ridgetops and upper slopes Cline and spurr (1942) found evidence of significant wind damage on low and mid-slopes as well.

Dominant overstory species show a range of tolerance to shade. Sugar maple and American beech are very tolerant, basswood is tolerant, white ash is intermediate and butternut is intolerant (Baker 1950).

Leak and Graber (1974) found that northern hardwoods generally occur below 850 m elevation. Sugar maple was found up to 825m on Mount Whiteface and up to 800m elevation on Mount Washington. Sugar maple was found in the overstory up to 820 m elevation on Haystack Mountain but was lacking in the understory above 720 m (Solomon and Leak 1994). The situation here is described as a catastrophic front where regeneration of sugar maple ceased about 100 years ago. The authors conclude that while there is no indication of a collapse elsewhere, the lack of sugar maple is common in understories and implies that "some reduction in sugar maple regenerative potential may be occurring throughout the study area" (Solomon and Leak 1994).

In their study of community organization of tree species along soil gradients, Bigelow and Canham (2002) found that *Acer saccharum* and *Fraxinus americana* were found at the upper end of the pH gradient and the upper end of the CA^{2+} gradient and were the only species to grow in soils with appreciable levels of NO_3^-. *Fagus grandifolia* was found on lower pH soils, but showed a growth response to high pH soils. *Acer saccharum* and *Fraxinus americana* did not, however, have a positive growth response to high pH soils suggesting that soil pH may be more important for seedling establishment than for long term growth.

POTENTIAL THREATS

Habitat Loss

Habitat loss in all its possible forms is perhaps the greatest threat to this community as it is to diversity everywhere. Because this community is the result of unique edaphic

conditions, and requires a mature canopy, it is not easily replaced once lost. Threats to the canopy include disease and forestry activities. The fertility of lands supporting rich woods have made them attractive for agriculture and have led to their destruction. MacDougall (2001) reports that current rich mesic forest occupy only one percent of their former area in New Brunswick.

Disease

Disease among the canopy species of the rich woods is a concern for all the herbaceous species adapted to the seasonal light conditions and nutrient balance beneath the canopy.

Excessive crown dieback of *Acer saccharum* was recorded in 1988 (7 percent of trees in unmanaged stands) and was of great concern to those dependent on the sugarbush. By 1992 excessive dieback had moderated, affecting 4 percent of the trees in unmanaged stands. Dieback has been associated with insect defoliation (pear thrips), drought, lack of nutrition (particualrly Ca, Mg, and K), stand density, logging, and root freezing (Long et al. 1977, Houston 1999, Horsley et al. 2000 in Morin et al. 2001). Average mortality of canopy and subcanopy trees was 0.6% and 1.7% per year, respectively, since 1989 (USDAFS 2002). Brown (1983) lists sugar maple borer is a serious pest (*Glycobius speciosus* Say). Other pests of *Acer saccharum* include *Nectria* canker and *Eutypella parasitica* Davids & Lorenz – maple canker.

Beech bark disease has had a significant impact on the health of *Fagus grandifolia.* The beech scale insect has spread south and west from the Canadian Maritimes since its introduction before 1890 (USDAFS 1992). Beech bark disease is spread by the beech scale insect (*Cryptococcus fagisuga*) that feeds on the bark. The resulting wounds are then susceptible to the fungus *Nectria coccinea. Nectria* kills the bark and outermost sapwood and leaves it susceptible to infection by other fungi (Archibald 1995).
The mortality of *Fagus* in Maine, Vermont, Massachusetts and New York was greater than that of all other species in those states in the early 1990s (USDAFS 1992). Manion and Griffen (2000) report a 39% mortality among mid size beech stems in the Adirondack Park.

Other threats to the canopy include defoliators such as pear thrips, forest tent caterpiller, Bruce spanworm, fall cankerworm, maple leafcutter and the saddled prominent. Basswood thrips have been a problem mainly in the lake states (USDAFS 1992).

The butternut canker, caused by the fungus *Sirococcus clavigignenti-juglandacearum,* is perhaps, the greatest threat to *Juglans cinera.* It was first reported in Wisconsin in 1967 (Anderson 2002) and has since spread to 26 states from Minnesota to Maine and south to Arkansas and the Carolinas. Over half the remaining butternut is present in the north central states. (USDAFS 1992). Infected *Juglans cinerea* are reported in the Saint John River Valley, but has yet to have a serious impact (MacDougall 2001). There is no known cure for the canker, but disease free, resistant trees have been found in 19 states. See *Juglans Cinerea* Conservation Assessment (2001) and work of Bergdahl and Halik University of Vermont for more information.

Logging

In a study and literature synthesis of herbs growing in eastern forests of the Southern Appalachians, Meier *et al.* (1995) found that species diversity was lowest in areas that had been clearcut, intermediate on areas that had been selectively cut and highest in areas uncut. The authors suggest that their results "suggest that one of the reasons herbaceous alpha diversity is lower in logged than in unlogged cove forest is that logging disturbs or removes less common species. Having few and small populations in scattered patches may place a species at risk, because it increases the probability that all the populations of a species will be damaged or extirpated." In an examination of species richness in second growth forests of various ages, the authors found "an initial loss of vernal herbs soon after clear-cutting, followed by a lack of recovery, if not continuing losses, of vernal herbs through age 87 yr."

Spring ephemerals in relatively undisturbed forests rely on biotic and abiotic factors such as light, pollinator, and nutrient availability, species-specific microhabitats, canopy species and stand history for conditions necessary for survival (Meier et al. 1995). Change or elimination of the canopy can be detrimental to these populations.

Increased summer temperatures caused by clear-cutting, can result in increased metabolic costs to vernal herbs. "Many vernal herbs lack the ability to sustain such costs and may experience mortality or at least fail to reproduce (Nault and Gagnon 1993 in Meier et al 1995). "Open successional sites and the initial stages of forest regrowth may also be more prone to browsing by white-tailed deer" (Alverson et al. 1998 in Meier et al. 1995).

Impacts of deer browse on herbs of the rich woods can be severe due to their growth patterns. "Plants of late-successional or mature forests grow slowly, some species requiring a decade or more from seed to first flowering (Curtis 1943, Bierzychudek 1982). Upon reaching maturity, many vernal herb species produce few seeds… Many species also demonstrate slow rates of growth" (Meier 1995). *Dryopteris spinulosa* (a species with which *Dryopteris goldiana* is known to hybridize (Haines and Vining 1998) was found to grow from less than 1cm to less than 4cm per year.

Because of the limited dispersal abilities of many of the rich woods species, recovery times for herb species diversity following timber harvest are exceedingly long (Meier et al. 1995).

MacDougall (2001) found in the Meduxnedeag River watershed of New Brunswick that a number of "immature" tolerant hardwood woods stands contained rare species, suggesting that they can withstand some forms of selective harvest. *Dicentra canadensis* may be one of the less demanding species of concern in the rich woods. Where *D. canadensis* is found adjacent to a clearcut on the White Mountain National Forest, it has been observed reinvading the regenerating clearcut after only 4 years (Species Viability Evaluation Expert Panel 2002).

Invasive species.
Patches of rich woods with their high species diversity and lush abundance of herbs may be somewhat resistant to invasion by exotic species (cite), however, disturbance (forestry activities, land development for roads, powerlines, homes) near or within these patches, will increase their vulnerability greatly. The high pH and nutrient rich soils make

favorable growing conditions for many invasives, especially if the heavy shade of the canopy is altered. Thompson and Sorenson (2000) list the following invasive species to the rich northern hardwood forest of Vermont; Morrow's honeysuckle (*Lonicera morrowii*), tartarian honeysuckle (*Lonicera tatarica*), Japanese barberry (*Berberis thunbergii*), and common buckthorn (*Rhamnus carthartica*).

Table 12 summarizes the threats to individual species compiled from individual species conservation assessments and literature searches.

Table 12. Threats to Regional Forester Sensitive Species

Species	Habitat loss or alteration	Fragmen-tation	Invasive species	Harvest/ collection	Forestry	Roads/trails	Herbivory	Disease	Climate change	Atmospheric deposition	Genetics
Blephilia hirsuta					ŏ		ŏ				
Carex aestivalis											
Carex baileyi						ŏ					
Collinsonia canadensis	ŏ					ŏ					
Cypripedium parviflorum var. *pubescens*	ŏ	ŏ	ŏ	ŏ		ŏ	ŏ				
Dicentra canadensis											
Dryopteris filix-mas			ŏ		ŏ	ŏ	ŏ	ŏ			
Dryopteris goldiana	ŏ	ŏ			ŏ						
Eupatorium purpureum	ŏ					ŏ					
Juglans cinerea								ŏ			
Osmorhiza berteroi	ŏ				ŏ				ŏ		
Panax quinquefolius	ŏ			ŏ	ŏ						
Petasites frigidus var. *palmatus*	ŏ					ŏ	ŏ				
Phegopteris hexagonoptera	ŏ		ŏ		ŏ	ŏ					
Platanthera orbiculata				ŏ							
Pyrola asarifolia	ŏ					ŏ		ŏ		ŏ	
Pyrola chlorantha											
Triphora trianthophora	ŏ*			ŏ?	ŏ	ŏ	ŏ?				ŏ?
Uvularia perfoliata				ŏ							ŏ

Compiled from individual species conservation assessments.
* Lack of disturbance may detrimental to this species.

SUMMARY OF LAND OWNERSHIP AND EXISTING HABITAT PROTECTION

New Hampshire

A number of rich woods sites are protected by the White Mountains National Forest and at least one additional site is protected as a State Park (Table 13).

Table 13. Examples of protected Rich mesic forest in New Hampshire.

Name	Location	Ownership
Sugarloaf Cove Sundown Ledge	Albany: Carrol	White Mountains National Forest 2 sites
	Bartlett: Carrol	White Mountains National Forest or Bartlett Experimental Forest
Black Mountain Sugarloaf Mountain Jeffers Mountain	Grafton: Benton	White Mountains National Forest 4 sites total
	Coos: Jackson	White Mountains National Forest
	Coos: Northumberland	White Mountains National Forest?
	Warren: Grafton	White Mountains National Forest 5 sites
Weeks State Park	Coos: Lancaster	

Maine

About nine sites in Maine are protected by the White Mountains National Forest and at least one additional site is protected by the State of Maine.

Table 14. Examples of protected Maple-basswood-ash forests in Maine.

Name	Location	Ownership
Evans Notch Hastings Mountain	Oxford: Batchelders Grant	White Mountains National Forest Two sites total.
Miles Notch	Oxford: Stoneham	White Mountains National Forest
Haystack Notch	Oxford: Mason Township	White Mountains National Forest Haystack Mountain 7 acre stand Registered critical area #51 for rare plants. Three sites total.
Albany Mountain	Oxford: Albany Township	White Mountains National Forest Three sites total.
Squa Pan	Squa Pan TWP Aroostook	Maine Public Reserve Land?

Vermont
There are many examples of Rich northern hardwood forests in Vermont and many are protected by the Sate of Vermont. Not listed here are the sites protected by the Green Mountain National Forest.

Table 15. Examples of protected Rich northern hardwood forests in Vermont.

Name	Location	Ownership
Equinox Highlands Natural Area (Mt. Equinox and Mother Myrick Mt.)	Manchester and Dorset	Equinox Preservation Trust, TNC, Vermont Land Trust, University of Vermont
Gifford Woods State Park	Sherburne	Vermont Department of Forests, Parks, and Recreation
Willoughby State Forest	Westmore and Sutton	Vermont Department of Forests, Parks, and Recreation
Merck Forest	Rupert	Merck Forest and Farmland Center
Emerald Lake State Park	Dorset	Vermont Department of Forests, Parks, and Recreation
Coolidge State Forest	Plymouth, Shrewsbury and Sherburne	Vermont Department of Forests, Parks, and Recreation
Chickering Bog	Calais	The Nature Conservancy
Pine Mountain Wildlife Management Area	Topsham, Newbury, Groton and Ryegate	Vermont Department of Forests, Parks, and Recreation

From Thompson and Sorenson (2000)

New Brunswick
MacDougall and Loo (1998) write about the rich woods of the Saint John River Valley (SJRHF) saying "It is estimated that SJRHF once occupied at least 200,000 hectares within New Brunswick's central St. John River Valley, based on the topography and distribution of well-drained calcareous soils within the region (MacDougall 1997). This figure increases when eastern Aroostook County is included, though the exact quantity of suitable habitat there is unknown. This pre-European forest would have been mostly continuously distributed, occupying the well-drained bottomland areas and flat and gently-sloped uplands within the valleys of the region. Today, only 0.8% of the area deemed suitable for SJRHF actually supports mature hardwood forests (MacDougall 1997). Fifty-five percent of the remaining land base is permanently cleared for farming, settlements, or roads. Most existing forest patches are second-growth stands of poplar, white birch, white spruce, and young tolerant hardwood on abandoned farm land or on areas that have been logged. The few locations that still support mature SJRHF tend to be small-sized, averaging just over 10 ha, and are isolated. Further complicating the issue is on-going disturbance of remnant SJRHF stands. A recent assessment of SJRHF patches determined that even though they only occupy a small percentage of the total landscape, 44% of the known sites had been completely or partially clearcut within the past 16 years (1981-1997), and only 6% of the stands showed no evidence of at least some past cutting (MacDougall 1997). If these trends continue, there will soon be little or no mature tolerant hardwood left in the central St. John River Valley. Remnant SJRHF assemblages in the central St. John River Valley are largely confined to the isolated mature patches.

Few SJRHF ground flora species, especially rare species, are found in the younger, regenerating stands (Matlack 1994, Meier et al. 1995, Damman and Cain 1998)."

SUMMARY OF EXISTING MANAGEMENT ACTIVITIES

There is no available information on management and/ or monitoring activities for this community type on the WMNF.

Because the species of concern here can often maintain reproducing populations in small areas less than an acre in size, the temptation may be to preserve each of these populations. However, a site with the potential for long term viability that provides conditions and natural disturbance at a scale necessary to maintain community functions rather than individual species functions will be preferable.

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